AN ECONOMIC AND OPERATION MODEL FOR THE GROWOUT OF FLORIDA POMPANO IN SEA CAGES.

John F. Coburn*, Michael F. McMaster and Thomas C. Kloth

Mariculture Technologies International, Inc.
860 South U.S. Highway #1
Oak Hill, FL 32759
coburn@mariculturetechnology.com

Abstract

As opportunities improve for use of Sea Cages offshore as well as in U.S. waters, due- diligence analysis becomes critical to successful funding and operational decision making. A significant amount of information is available in the technical literature concerning potential marine finfish to be the target for Sea Cage ventures. This study focuses on the behavior aspects, hardiness and growth rates and uses the Florida Pompano as the model species for the methodology and analysis presented.

Sea Cage operations are but one component of the Venture, or in Model terms, the Plant. Hatchery Operations need to be located within economic proximity and therefore along with product handling, feed and other materials storage and handling lead to required investments in facilities. Both the Capital and Operational Costs for the Plant need to reflect scale factors as well as species specific characteristics. Labor, material and shipping costs are geographic dependent, as well as scale/volume related.

Yield of marketable product must be stated in terms of large populations and density rather than small tank experience. In many cases, one can only estimate the extrapolations but a simulation model such as used in this study can provide sensitivity analysis and performance targets. Current market prices are used to generate an expected margin and potential return on investment.

At this point, only preliminary results are available for the operational modeling of the Sea Cage Plant. The experience of Mariculture Technologies International, Inc has been extensively tapped to provide input to the model based on the Florida Pompano. This model becomes a benchmark against which other marine finfish, operating approaches, and grow-out plant sitings can be compared.

Background

This technical paper describes the use of Process Models along with Computer Simulation to analyze the Economics and Operations of Growing Pompano in Open Ocean Sea cages. The coauthors are associated with Mariculture Technologies International and have extensive experience with Pompano fry production and grow-out.

Even in those cases where a Process is relatively straight-forward, drawing a Process Flow Sheet is strongly recommended. It only takes a few components to render the “Black Box” approach to Process Analysis a candidate for Chaos Theory.

The Flow Sheet constitutes a Process Description. A design for the Operations. With a concise description, one can proceed with detailed Investment Analysis as well as an Outline for Operational characterization including steps toward optimization. Finally, the Process Flow Sheet is the first step in conducting a Hazard Analysis of Critical Control Points or more widely known by its initials, HACCP.

Discussion

Process Models/Simulation

1. **Prepare Process Diagram (Flowsheet)**
2. **Set Properties for each Activity**
    - **Duration**
    - **Resources/Costs**
    - **Decision output ratios**
3. **Run Scenario**

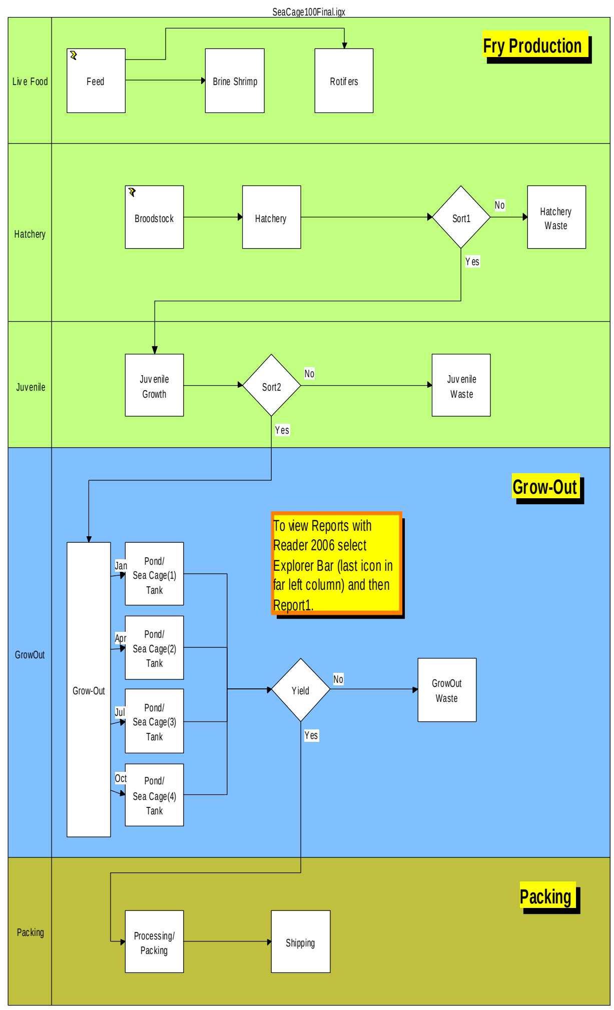
Starting with the Process Diagram or Process Flowsheet (Step 1), a computer model capable of simulating actual operations requires the same information (in computereze, Properties, Step 2) as traditional economic and operations would: Durations, Resources, Decisions).

And finally a Run Scenario (Step 3). How many days? What sort of Calendar?

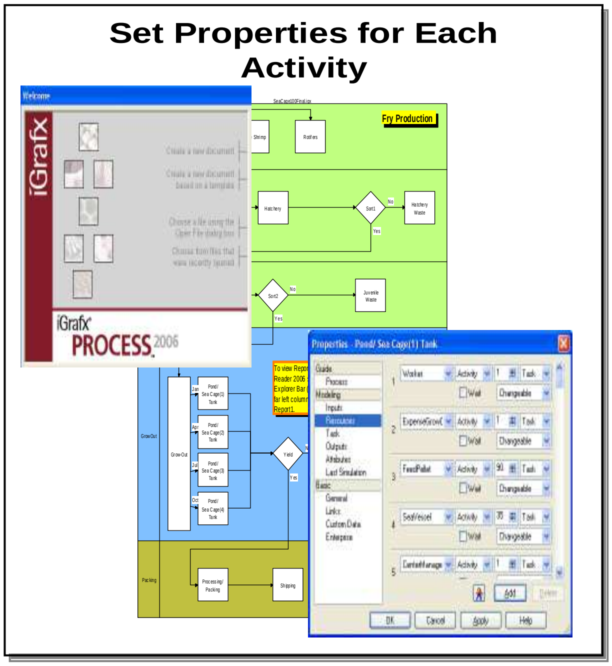
Here is the Process Diagram or Flowsheet for a Pompano Plant It’s a generic model which could be used for any Finfish as well as for Grow-out in containers other than Sea Cages. Due to time constraints, the “Sanitation” Department which would have run across the bottom of the Flowsheet was omitted.

The Diagram is color-coded with green representing “Fry Production”, Blue representing “Grow-out”, and Gold “Packing”.

Process Diagram for a Pompano Plant



The computer program used is iGrafx Process 2006 from iGrafx/Corel (trial versions are available, www.iGrafx.com).



To set Properties for an activity, double clicking the activity on the Process Diagram opens a window wherein Resources, Task Durations, and Output Characteristics can be Set. Here are some of the Resources for SeaCage(1): 1 Center Manager, 35 days of Sea Vessel, 90 metric tons of Feed Pellets, etc.

At the end of a simulation run, Reports are generated detailing Time elements, Cost, Resources and Queues (waiting times associated with bottlenecks within the process). Here is about one-third of the Cost element. All of the Reports are included in the SeaCage100Final file which is available from the authors.

Reports: Time, Cost, Resources, Queues

"Grow-out Model for Florida Pompano in Sea Cages"

J.F. Coburn, M.F. McMaster and T.C. Kloth
Mariculture Technologies International, Inc.

Transaction Statistics

Count	Avg Cost	Avg Lbr Cost	Avg Eq Cost	Avg Oth Cost	Avg Std Cost	Avg OT Cost
960000	$1.49	$0.36	$0.41	$0.72	$1.49	$0.00

Transaction Statistics

Count	Tot Cost	Tot Lbr Cost	Tot Eq Cost	Tot Oth Cost	Tot Std Cost	Tot OT Cost	Tot VA Cost	Tot NVA Cost	Tot BVA Cost
960000	$1433195.83	$348480.00	$393641.83	$691074.00	$1433195.83	$0.00	$1433195.83	$0.00	$0.00

Transaction Statistics

	Count	Tot Cost	Tot Lbr Cost	Tot Eq Cost	Tot Oth Cost	Tot Std Cost	Tot OT Cost	Tot VA Cost	Tot NVA Cost	Tot BVA Cost
GrowOut	345600	$1039004.79	$112000.00	$261004.79	$666000.00	$1039004.79	$0.00	$1039004.79	$0.00	$0.00
Hatchery	480000	$97216.56	$29760.00	$67456.56	$0.00	$97216.56	$0.00	$97216.56	$0.00	$0.00
Juvenile	384000	$126344.32	$89280.00	$22264.32	$14800.00	$126344.32	$0.00	$126344.32	$0.00	$0.00
Live Food	480000	$165621.20	$115200.00	$40147.20	$10274.00	$165621.20	$0.00	$165621.20	$0.00	$0.00
Packing	311040	$5008.96	$2240.00	$2768.96	$0.00	$5008.96	$0.00	$5008.96	$0.00	$0.00

Total Cost

CenterManagerQTR	$313920.00
Electric	$65185.20
ExpenseGrowOut	$348032.62
ExpenseHatchery	$58703.04
ExpenseJuvenile	$16323.84
ExpenseLiveFood	$18992.16
ExpensePackShip	$44628.96
ExpenseQaAdminQtr	$30345.60
ExpenseTransportQtr	$103593.60
ExpenseWaterPlantQtr	$4394.88
FeedPellet	$680800.00
MicroFeeds	$10274.00
QAManagerQtr	$104640.00
SeaVessel	$112000.00
Worker	$627840.00

It is these reported results that are used in describing the Economics in the figures that follow.

Alternate Cases: Low and High Density

- Low (15 kg/M^3)
- Batch: 100,000 fish
- Cages: 3000 M^3
- Cage Count: 4
- Yield: 182,000 kg
- Cycles: 4 (93.4 wk)

- High (36 kg/M^3)
- Batch: 250,000 fish
- Cages: 3000 M^3
- Cage Count: 4
- Yield: 455,000 kg
- Cycles: 4 (93.4 wk)

Two cases, a Low and High Density of fish in the Sea Cages were run through the Simulation. The High Density Case corresponds to that reported in 2001, 2002, and 2003 by Dr. Benedict Posadas of Mississippi State University and the Cages were 3000 cubic meter Ocean Spar Sea Station cages. While Dr Posadas's 2001 Paper included both 6 and 12 cage grow-out, his later papers were 12 cage only.

A scenario using 4 cycles of the hatchery per year (driven by the 3-month period from egg to stockable 10 gram juvenile fish) directed to 4 Sea Cages was employed in our study. Clearly, other combinations could be modeled and analyzed.

Equipment Employed

	Low	High
Water Plant	$ 10,930	$ 27,325
Live Food	$ 59,400	$ 148,500
Hatchery	$ 238,200	$ 595,500
Juvenile	$ 51,400	$ 128,500
Sea Cages	$ 660,000	$ 660,000
Pack/Ship	$ 107,000	$ 267,500
QA/Admin	$ 71,000	$ 177,500
Transport	$ 241,000	$ 602,500
Sea Vessel	$ 112,000	$ 224,000

Annual Expense for "Equipment" employed is based on Depreciation and Maintenance except for the Sea Vessel which was a Contracted Service. Structures were depreciated over 10 years and Equipment over 5 years. Maintenance was taken as 10% per year. In general, the High Density Case holds the Sea Cages constant while increasing Land Operations by a factor of 2.5 to support the greater numbers of fry required.

As is apparent, the Land-Based Investment is equal to or greater than the Sea-Based Investment even in the Low Density case.

Labor Employed

	Wage/ hr	Low	High
Center Mgrs	$20.00	3	3
QA Manager	$20.00	1	1
Workers	$7.50	16	40

Direct Labor consisted of workers, paid at the rate of $7.50 per hour and Supervisory personnel paid at the rate of $20 per hour.

No additional supervisory personnel were added to support the High Density case.

Other Resources Employed

	Unit Cost	Low	High
Micro Feeds	$5.50/Kg	$10,274	$25,696
Feed Pellet	$1,850/MT	$680,800	$1,706,880

Other Resources Employed consisted of the Feed Costs shown here. Micro Feeds (at $5.50 per Kg) were consumed in the Brine Shrimp and Rotifer Tanks and Feed Pellets (at $1,850 per Metric Ton) in the Juvenile Tanks and Sea Cages. The difference between Low and High Density is simply the factor of 2.5

Using the categories of expense just reviewed, it is straightforward to use the Reporting system from iGrafx Process to produce summaries. Expenses fall into the headings of Labor, Equipment, and Other (Feed).

Results

Turning to the Conclusions from the Simulations: "Love Your Hatchery Management!" No brine shrimp or rotifers results in no fry. No fry leads to no fish production.

Love Your Hatchery Management!
($ per 0.5kg Pompano)

	Low Density	High Density
Fry Production	$ 0.97	$ 0.76
Grow-out	$ 2.60	$ 2.23*
Packing	$ 0.01	$ 0.01
Total	$ 3.58	$ 3.00

*Comparison: B.C. Posadas (Aquaculture America 2003), excl Hatchery: Snapper (454g) $2.03 per fish

Fry Production, extending from egg to 10 gram juvenile fish, includes the costs of brine shrimp and rotifers and amounts to approximately 25% of the total cost of the adult fish.

Regarding the Grow-out, the High Density Case showed a 15% reduction in contribution to cost. This impact of more than doubling the Cage density is lower than one might first expect. The greater corresponding Land-based costs and the constant Feed Costs prevent simply reducing Grow-out costs by the greater (2.5X) utilization of the Cages.

The 2 cases result in a cost per 0.5 Kg Pompano of between $3.00 and $3.58.

For comparison, the results reported by Posadas for his 12 cage model ex-vessel and excluding Hatchery expense was $2.03 per fish for a comparable-size fish.

Feed Costs Dominate
($ per 0.5kg Pompano)

	Low Density	High Density
Feed (FCR 2.0)	$ 1.73 (48%)	$ 1.73 (58%)
Labor	$ 0.87 (24%)	$ 0.60 (20%)
Equipment	$ 0.82 (23%)	$ 0.54 (18%)
Electricity	$ 0.16 (5%)	$ 0.13 (4%)
Total	$ 3.58	$ 3.00

Feed Costs Dominate accounting for 48% to 58% of the Total cost per Pompano. These calculated numbers are at a FCR of 2.0 as was used in the Posadas Paper. This is an important factor and needs to reflect the "Practical" FCR as contrasted to a laboratory results. In our 2006 Paper, we used an FCR of 2.2 for Pompano raised in Ponds and that FCR could be low as applied to Sea Cages.

Labor accounted for 20% to 24% of Total Cost while Equipment came in at 18% to 23%.

For this Table, the cost of Electricity has been broken-out because it represents an area for cost reduction. Electric resistance heating for the Broodstock and Hatchery Tanks could and probably should be replaced by either higher efficiency heat pumps or alternate energy sources such as solar heating.

The costs that I've shown represent only Direct Costs. The Sea Cage Enterprise must still pay for Indirect Costs and a Return to Investors. Whether the margin of $2.00 between Direct Cost of $3.00 and a Market Price of $5.00 is sufficient for Profitability, I leave to you.

Toward Profitability

- **Seek lower feed costs.**
- **Optimize Plant Scale (land- and sea-based operations).**
- **Invest in alternate for electric resistance water heating.**
- **Flexible, well-trained workforce.**

Here are some of the areas that were identified from the simulations. I think they apply regardless of how effective equipment manufacturers are at reducing the cost of the major items.

The WorkForce opportunity didn't get any attention during the presentation but the scenarios used assumed that workers were moved between "departments" as needed by the activities. To be able to, in practice, so operate requires a flexible, well-trained employee.

Future Modeling Studies

- **Open Ocean Sea Cages (updates)**
- **Near Shore Surface Cages**
- **Pond Aquaculture**
- **Recirculation Tanks/Ponds**

Having constructed the generic model for the Pompano Production Process, and having become more knowledgeable about the iGrafx Process software, here are some potential Future Modeling Studies.

Updates to Open Ocean Sea Cages to reflect Equipment improvements.
Near Shore Surface Cages with smaller batch sizes.
Pond Aquaculture, and
Recirculation Tanks or Ponds.

Of course, one can lay-over this menu, other species of finfish which have different growth curves and preferences.